



*Air-conditioned driver's cabin
on an overhead crane at Spän-
narhyttan Steelworks, Sweden.
(F 655)*

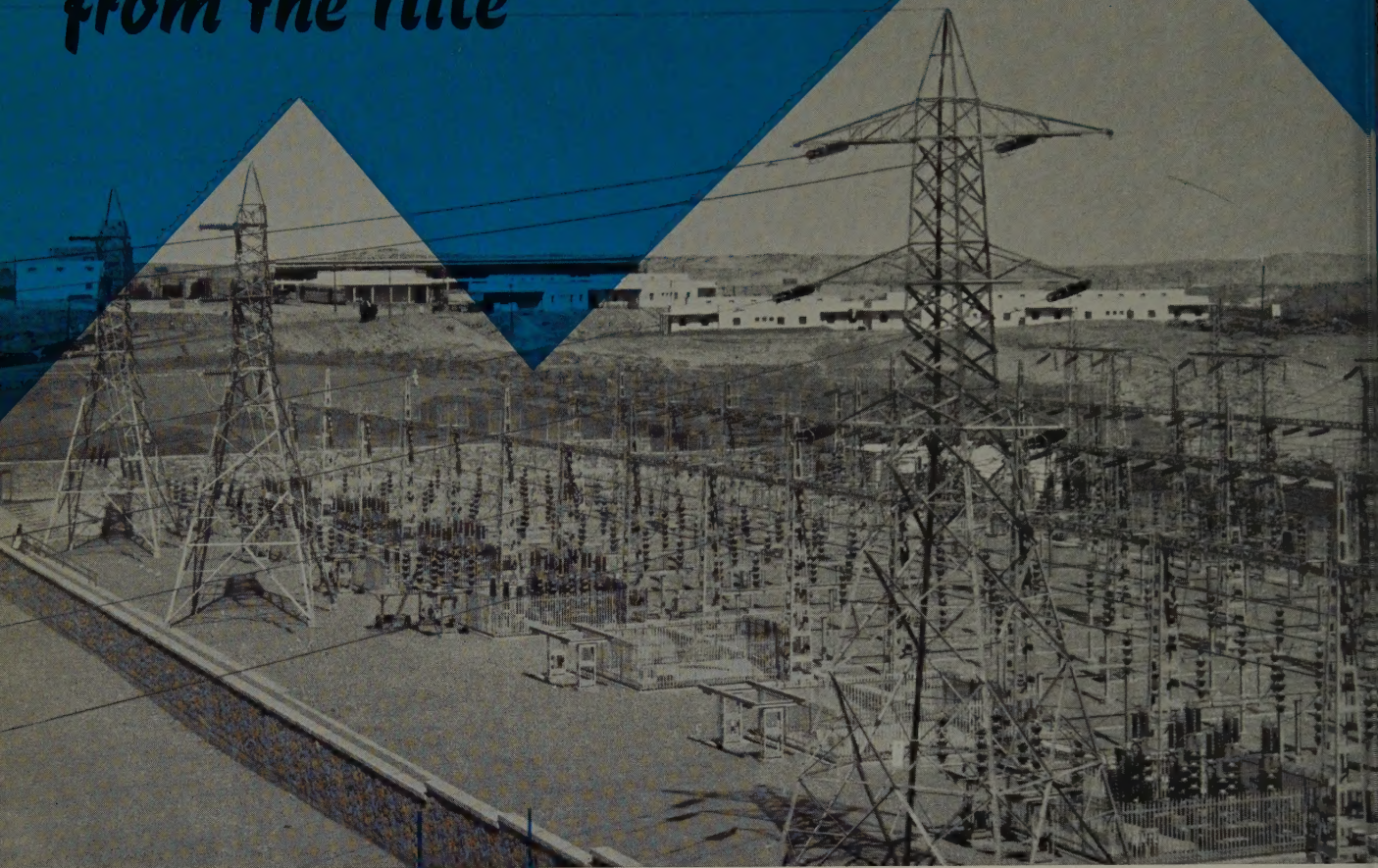
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DRIVER'S CABIN FOR OVERHEAD TRAVELLING CRANES

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Asea Reg. 6341

Various organisations and companies have taken an interest in the working conditions of crane drivers, and a recommendation on the designing of driver's cabins has been issued. Asea have taken an active part in this work, and the article supplies information concerning the main points in the recommendation, as well as a description of the Asea driver's cabin which was designed on the basis of the above.

An overhead travelling crane of older design was usually provided with a driver's cabin, the size and appearance of which were entirely determined by the controls, crane motor starters and also, perhaps, by the controller resistor. The design and location of the electrical apparatus meant that the driving position of the driver became very uncomfortable; visibility was by no means satisfactory. Therefore, loads had to be carried at low speed and with great care so that accidents could be avoided.

Increased production made greater demands on the capacity of the overhead cranes, their lifting capacity and speeds increased and greater demands were made on their safety and reliability. One of the consequences of these new requirements was that the working conditions of the driver had to be improved and the visibility and driving position had to undergo a radical change.

Asea became interested in this problem at an early stage. Controllers for the main current were replaced by more readily operated pilot controllers, and the cranes were provided with a comfortable driver's seat – a luxury which had been unthinkable previously.

Eventually, the working conditions of crane drivers captured the interest both of managements and the trade union organisations. The driver's place of work, the cabin, was studied and its design discussed by works engineers, manufacturers and physiologists, and, for the first time, the points of view of the latter were seriously taken into consideration when arriving at decisions. The discussions finally led to a recommendation being issued on the design of the driver's cabin.

What then are the demands which are made on a driver's cabin and what have Asea accomplished in order to fulfil these wishes?

TYPES OF DRIVER'S CABIN AND THE LOCATION OF THE CABIN

The local conditions are the decisive ones when deciding whether the cabin is to be open (Fig. 1) or closed (Fig. 2). In cold and draughty premises, when the ambient temperature is high, when the air is polluted, and out-of-doors, the driver's cabin should be of enclosed type. In heated premises with clean air, the cabin can be of open design.

The cabin must always be so located that good visibility and safe handling of the load are obtained. Unless special conditions call for some other solution, the cabin should be situated next to the one end-trolley with the front facing in the longitudinal direction of the crane bridge, and so that the load is always ahead of, and to the right of, the driver's cabin.

Fig. 1. Open driver's cabin for overhead travelling cranes. (54940)

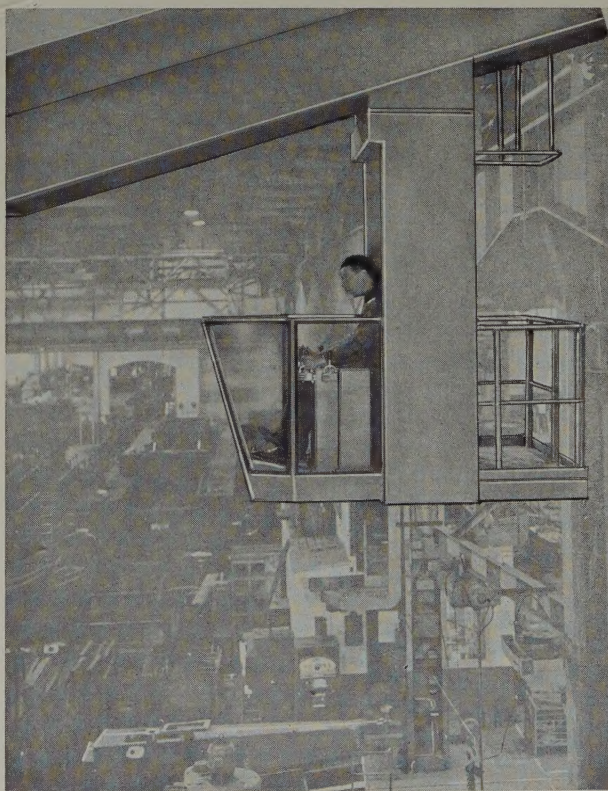




Fig. 2. Closed driver's cabin for overhead travelling cranes. (F 681)

VISIBILITY FROM THE DRIVER'S CABIN

The driver must be able to view the entire working range of the crane without difficulty, and he must be able to see the load during the entire process of transport. This means that the front part of the driver's cabin must be provided with generously proportioned windows. The frames between the panes of glass must be narrow.

The Asea driver's cabin is well provided for in this respect. The windows have large surfaces, the frames are of the smallest possible width and the panes are held in place by narrow rubber strips. The windows at

the lower part of the cabin are inclined inwards toward the bottom while the others are vertical. This design allows of good downward visibility. The view straight ahead is also unrestricted since the lower glass pane at the front is linked with the upper one by means of a transparent plastic strip. The driver can also see downwards and backwards through a generously proportioned window in the floor which is not covered by any grid. The window in the floor is inclined somewhat so that dirt, cigarette ash, etc. can roll down to the edge of the glass. Two of the upper windows at the front and the floor window can be opened. It is thus possible to clean the outer parts of the windows from inside the cabin.

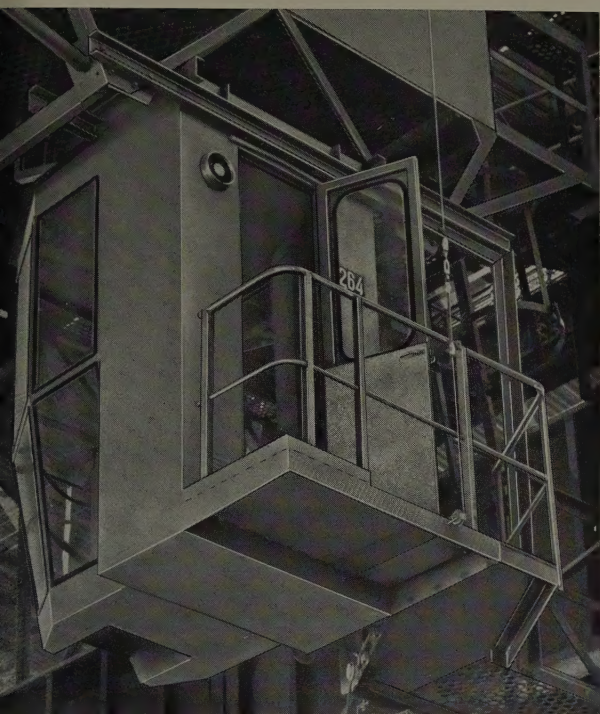


Fig. 3. In the rear wall of the cabin there is a door provided with a window and, outside this, a platform. (55785)

All the windows are made of toughened glass which stands up well to vibration, blows and heat radiation. The panes of glass can be changed from inside the cabin.

THE VOLUME OF THE DRIVER'S CABIN

The cabin must be large enough to permit the inspection and maintenance of the operating devices and other equipment without any difficulty.

The forward floor surface of the Asea cabin is small in order to provide adequate visibility downwards and backwards. Behind the controllers there is a space which allows the maintenance personnel to carry out inspections and repairs. The internal height of the cabin is about 2 m (7 ft).

THE DESIGN OF THE DRIVER'S CABIN

The cabin must be stable and fire-proof as well as being insulated against heat and cold.

The Asea cabin is built of bent sheet-steel and steel profiles. In the space between the outer and inner walls there is a mat of glass-wool which well protects the interior against external heat and cold. The floor and roof are insulated in the same way.

The cabin is normally provided with single panes of glass in the windows, but when particularly heavy demands are made on the insulation, double panes of glass can be mounted.

An air-conditioning set can be used for the cabin without having to alter the insulation. Filtered, cooled or heated air is then blown in through the perforated inner ceiling of the cabin.

The entrance to the cabin is at the rear (Fig. 3). Outside the door, which is provided with a window, there is a platform which may have to be designed to fit in with local conditions.

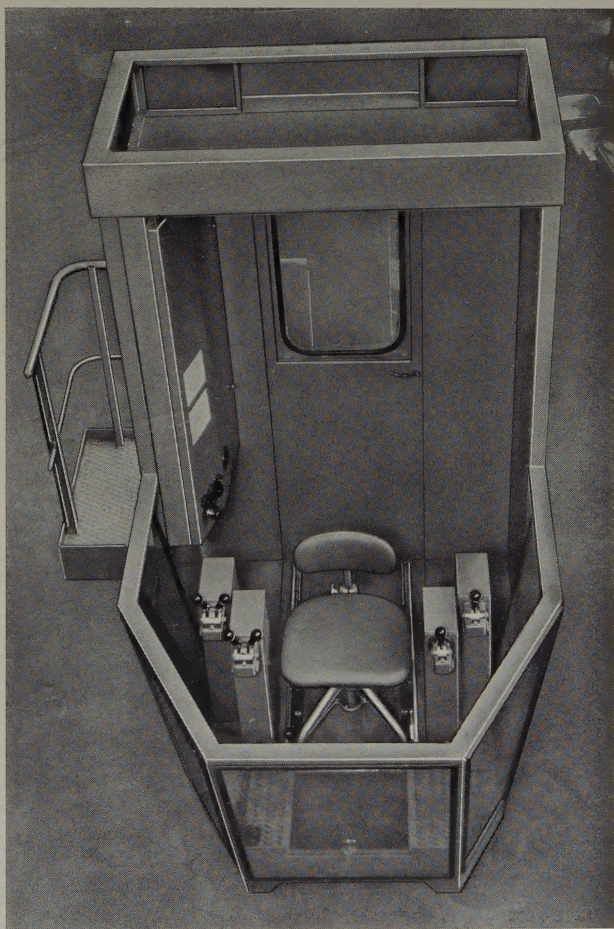
THE DESIGN OF THE DRIVER'S SEAT

The cabin must be provided with a chair the height of which can be regulated and which can be moved backwards and forwards. It must be able to provide the driver with a restful, but effective, working position.

The chair in the Asea cabin (Fig. 4) is mounted on a frame provided with rollers which run on rails fastened to the floor. The chair can be fixed in any desired position by means of an eccentric lock, which is so designed that the driver can move rapidly backwards into the cabin if danger should arise.

The back-rest of the chair, and the seat, are padded and covered with plastic-coated fabric. The chair can also be

Fig. 4. Driver's cabin with chair and operating devices. (53253)



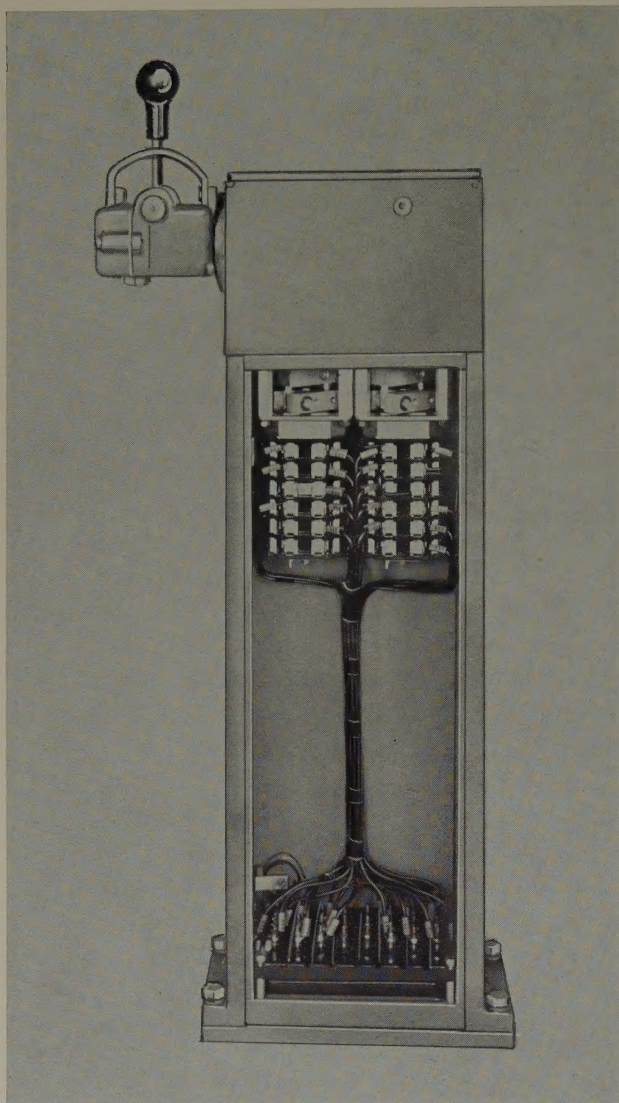


Fig. 5. The driver's cabin contains four control columns, each of which has one or two cam-switch units, thus allowing up to eight crane movements to be controlled at the same time. The controller is mounted on a base-plate with terminal clamps on the underside. Contacts on the upper side of the plate and corresponding pin contacts on the underside of the controller make it possible to change the latter readily and quickly. (53166)

raised or lowered. Next to the window in the floor there are two foot supports inclined at a comfortable angle and which are covered with ribbed rubber.

THE DESIGN OF THE CONTROL DEVICES

The controllers must be small and easily operated. The tracks of the levers must be within the movement range which is best for the driver. The vertical movements of the load are usually operated with the right hand and its horizontal movements with the left hand. Similarly, pushbuttons and signal equipment are located within the driver's range of movement.

Asea have designed an entirely new type of controller (type CKME), of column type (Figs. 4 and 5), which is completely adapted to the new cabin. The controller is operated by means of a lever. The travel of the lever is short and their height above floor level is about 900 mm (3 ft).

The column serves as a stand for the operating device but contains, in addition, one or two cam-switch units. Since each Asea cabin contains four column controllers it is thus possible comfortably to carry out eight crane movements. A controller with two cam-switch units can either be provided with two separate operating levers or with a common lever which actuates, via universal operating gear, either the one or the other cam-switch unit or both at the same time.

Each cam controller consists of a number of contact segments combined to form a unit which can easily be replaced. The contacts are designed for 10 A, 500 V. Each controller has four contact positions on each side of the neutral position.

The controller is mounted on a base-plate provided with terminal clamps on the underside and contacts on the upper side (Fig. 5). There are corresponding contact pins on the underside of the controller. The incoming leads can be connected to the terminal clamps of the base-plate even when the controller with the cam-switch units is not fixed to the latter. The base-plate is fixed to the floor of the driver's cabin and after the leads in the cabin have been connected up, the controller can rapidly be put in place. The contact pins provide immediate and reliable connection for the controller.

This design of controller means that no input leads have to be slackened if a controller has to be adjusted or changed because of a fault. The controller can rapidly be removed and replaced by a spare one, and therefore a fault in the controller need no longer give rise to lengthy interruptions in service.

In addition to controllers, various other pushbutton switches, instruments, etc. are required. These are arranged in a control cabinet located on the wall to the right of the driver. The cabinet is so designed that the operating devices are readily accessible.

In those cases where part of the travelling mechanism of the crane is provided with a foot-operated brake, the brake pedal is located so that it can be operated with the right foot. The transmission between the brake pedal and the actual brake is usually arranged with the aid of a flexible rod running in ball bearings, sometimes in conjunction with hydraulic mechanism.

When a foot-operated pushbutton is included in the regulating equipment, it is mounted in such a way that it can be actuated by the driver's left foot.

TRUCK-TYPE SWITCHGEAR FOR 20 KV

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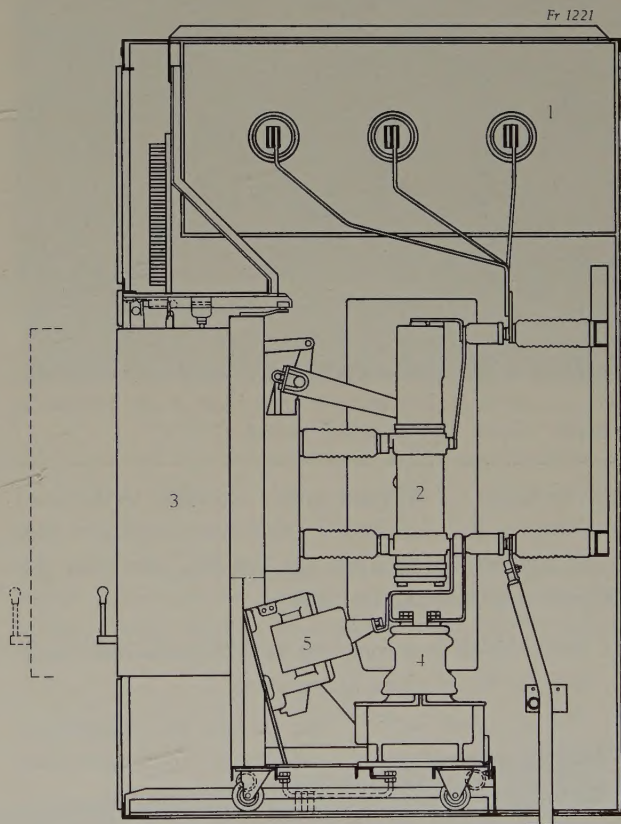
The article describes the newly designed Asea 20 kV truck-type switchgear. The smallness of the dimensions is stressed, and the circuit-breaker truck is described in some detail.

Since electricity authorities and industrial consumers are installing electrical power on an ever-increasing

scale, the need arises for switchgear for a higher service voltage than 10 kV. Asea have therefore designed switchgear with small dimensions for a service voltage of 20 kV (Fig. 1), for use with a single busbar and for setting up against a wall. The circuit-breaker truck has been designed for circuit-breakers with a breaking capacity of 400 or 600 MVA at 20 kV.



Fig. 1. Switchgear cubicle for 20 kV. The circuit-breaker truck is in the "Off" position, which is indicated by the operating gear projecting through an opening in the front of the cubicle. (51872)



- 1 Busbars
- 2 Circuit-breaker
- 3 Operating gear
- 4 Current transformer
- 5 Voltage transformer

Fig. 2. Vertical section through a cubicle for 20 kV. Height 2,400 mm (7 ft 10.5 in.), depth 1,570 mm (5 ft 2 in.). The truck is in the "On" position, whereby the circuit-breaker is connected to the busbars and the cable with socket-contacts of "tulip" type.

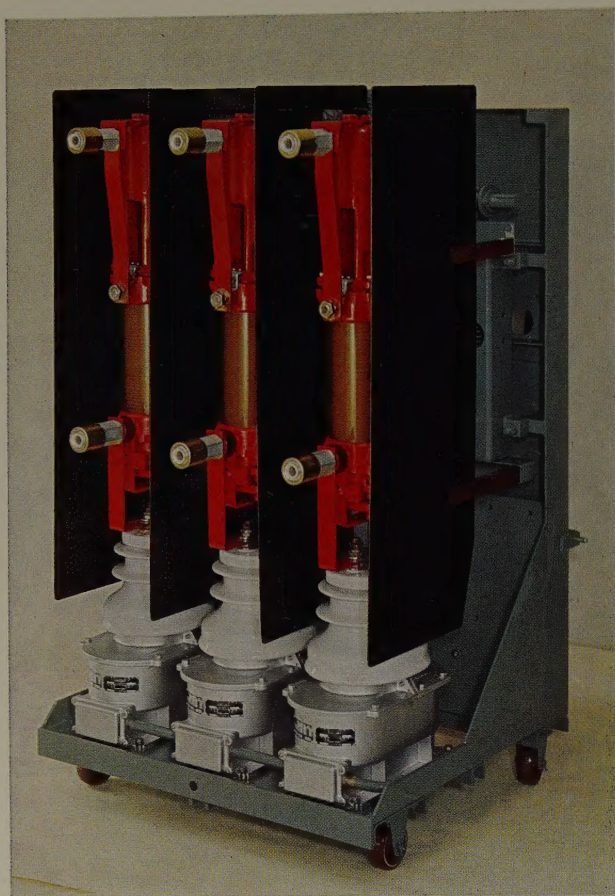


Fig. 3. The rear of the truck with circuit-breaker and current transformers. The truck is moved out of the cubicle on bakelite wheels, two of which swivel. (F 574)

The switchgear is designed mainly according to the same principles as the Asea 10 kV truck-type switchgear [see Asea Journal 29(1956):4, pp. 39-46], and has the following outstanding features:

1. Each cubicle is a complete unit in itself, with bushings for the busbars in the sides.
2. The top and back of the cubicle are designed as safety valves to release any excess air pressure that may build up.
3. The front is reinforced and fitted with a powerful lock and strong hinges.
4. Accidental contact with live parts is impossible even when the door is open; the truck completely covers any unscreened surfaces.
5. The trucks are interchangeable.
6. The truck is mechanically interlocked both with regard to its operation and movement inside the cubicle.
7. Erection on site is simple.

When the switchgear was designed, particular care was taken to make the cubicle as small as possible (Fig. 2).

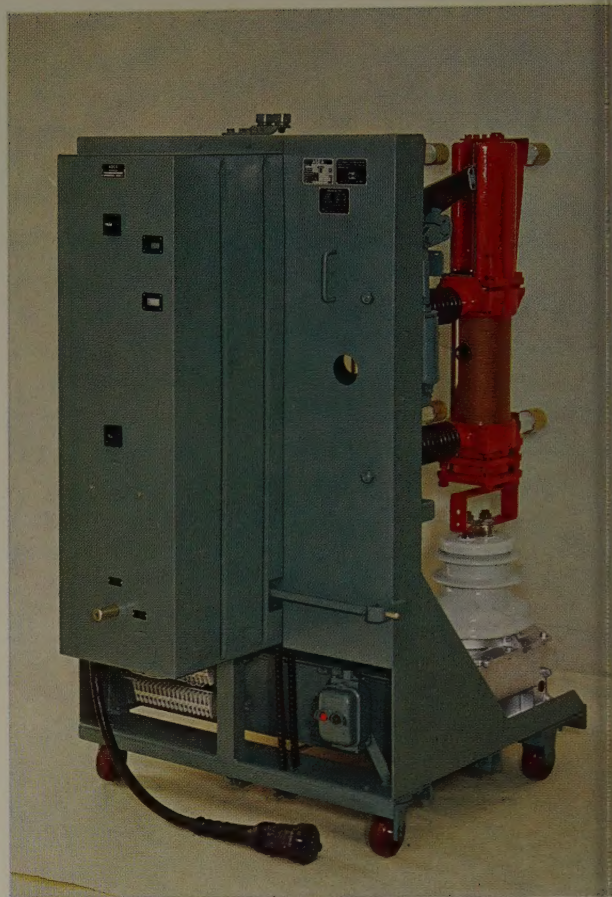


Fig. 4. The front of the truck with operating gear. (F 575)

In this way it has been possible to limit the height, for example, to 2,400 mm (7 ft 10.5 in.). The smallness of the dimensions means that space can be saved in new installations and that it may be possible to use existing premises when converting from a lower service voltage to 20 kV.

The circuit-breaker truck (Figs. 3-5) is robustly built and is designed to take, in addition to the circuit-breaker, instrument transformers (Figs. 2 and 3). The circuit-breaker is the oil-minimum circuit-breaker type HKB, which is mounted on a truck. The breaking capacity is 400 MVA at 20 kV. In cases where a higher breaking capacity is required, an oil-minimum circuit-breaker of type HKH with a breaking capacity of 600 MVA at 20 kV is used.

The truck can be moved inside the cubicle with the aid of grooved wheels underneath, and guide rollers above (Fig. 5), and outside the cubicle on bakelite wheels (Fig. 3), two of which swivel. When the truck is rolled into a cubicle, it is automatically stopped in the "Off" position. It cannot be pushed right in until a catch has been released, whereupon it can be cranked in to make connection with the busbars and cable with socket contacts of "tulip" type.

Fig. 5. The truck fully inserted in the cubicle. It is pushed on grooved wheels. The handle immediately above the crank is the operating handle for the locking device. (53537)

The truck is disconnected and connected merely by moving it inside the cubicle. This movement is carried out by means of a detachable crank, which is inserted into a hole in the front of the operating gear. The position of the operating gear in relation to the front of the cubicle clearly indicates whether the truck is standing in the "Off" or the "On" position.

The truck can be locked in the "Off" or the "On" position by means of a locking device, the handle of which is located at the front of the operating gear immediately over the crank (Fig. 5). Mechanical interlocking prevents the operation of the circuit-breaker if the truck is not in the locked "On" or "Off" position. The circuit-breaker is tripped if attempts are made to release the catch which holds the truck in the "On" or "Off" position.

As stated, the switchgear has been designed for a single busbar and for setting up against a wall (Fig. 6). In cases where double busbars are required, a double circuit-breaker system can be employed. This necessitates the use of two cubicles per group, in which case the cubicles can either be placed back to back, or face to face on each side of a gangway. In this instance the socket-contacts on the cable side are connected together.

This system increases service reliability and has the advantage that it is possible to replace circuit-breakers without interrupting service.

To supplement the above truck-type cubicle, there is a selection of other cubicle types with fixed circuit-breakers. They have the same outer dimensions and design as the truck-type switchgear and can be combined with it to make a complete switchgear unit (Fig. 6).

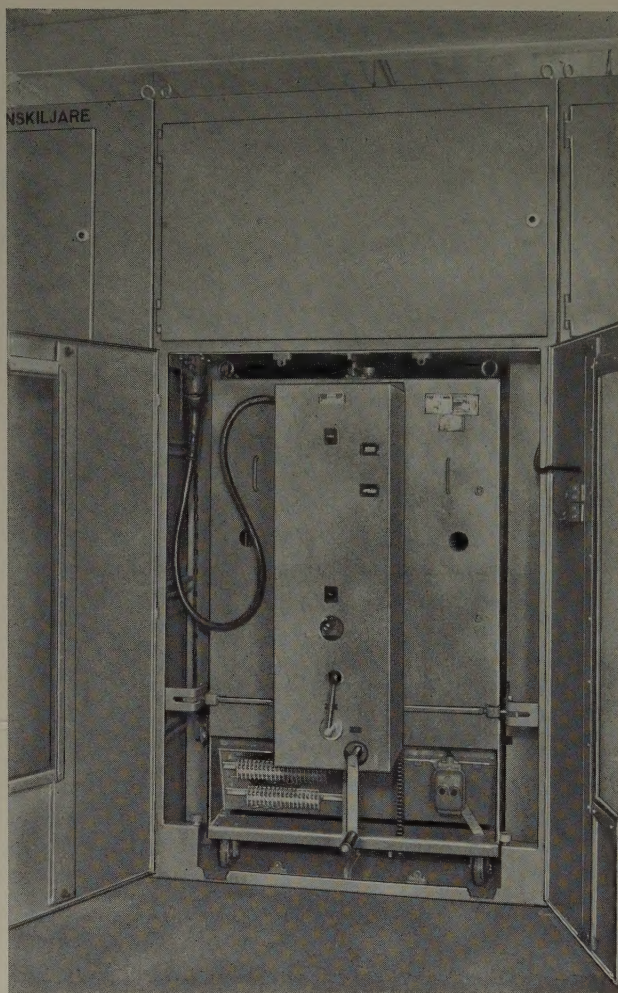
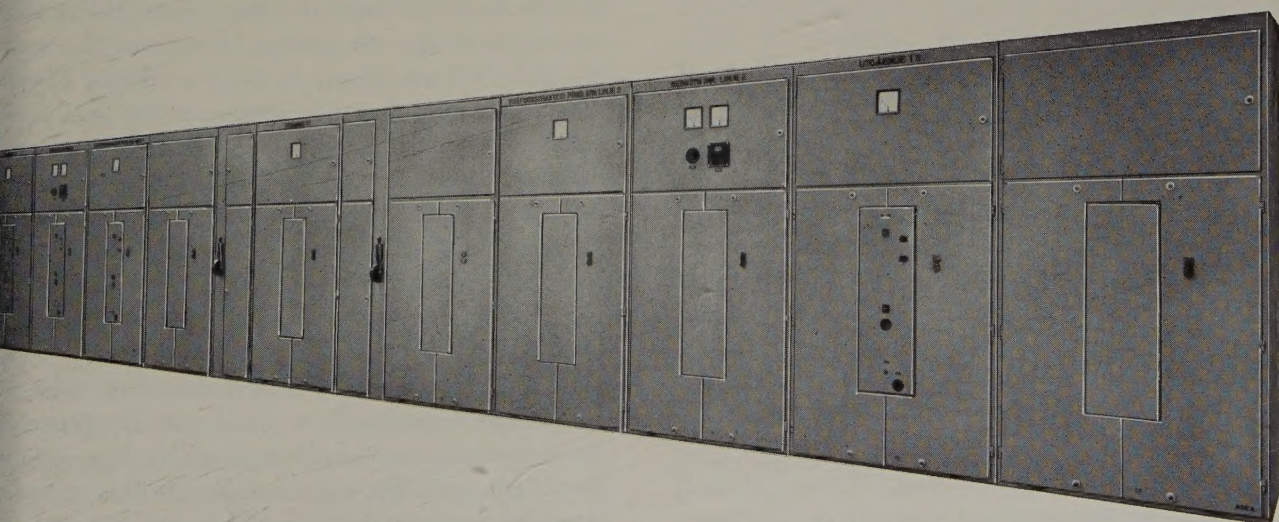


Fig. 6. Truck-type switchgear for 20 kV. It is designed for a single busbar and for setting up against a wall, but, by using a double circuit-breaker system, it can also be used for double busbars. (52075)



A TEST TO DESTRUCTION ON A HERMETICALLY SEALED TRANSFORMER OF DRY TYPE

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Asea Reg. 4743

The new Asea dry-type, hermetically sealed transformer with insulation of class H has been subjected to a fire and explosion test. The test has proved convincingly that this type of transformer can be classified as safe against fire and explosion hazards, even with extreme overloads and fault conditions. In the test described in this article, the insulation did not fail until a temperature in the vicinity of the melting point of the copper in the winding had been reached.

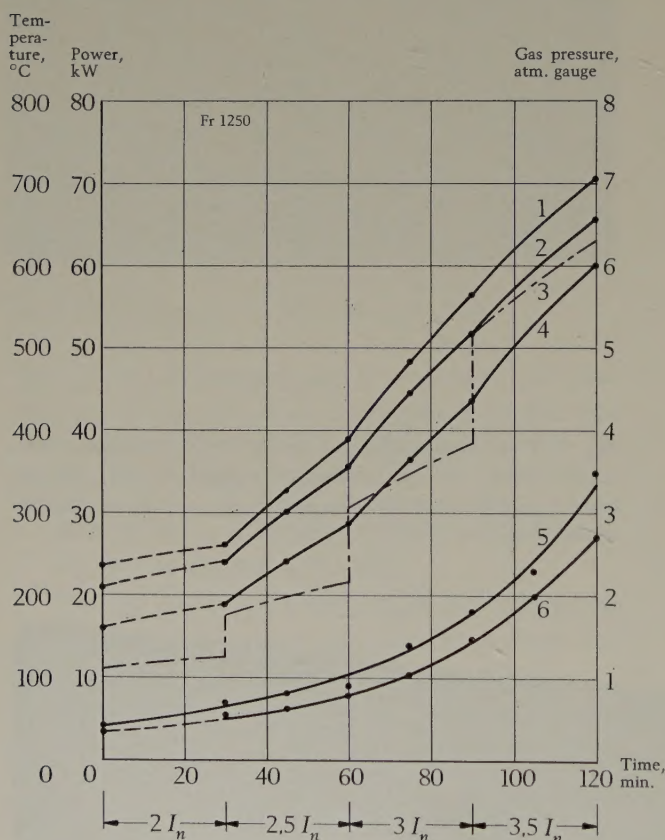
For the last few years Asea have been manufacturing dry type, hermetically sealed transformers, primarily for use in mines. The type is also of interest as an alternative to normal oil-insulated transformers for use at other sites, where, for example, the atmosphere is corrosive, damp or full of impurities. In each case local conditions as well as technical and economic considerations should decide which design is to be selected.

Since there are still no Swedish standards for this type of transformer, the American standards for temperature guarantees (ASA C57.12d-1957) are used. The permissible mean temperature rise for the winding is 150°C and the maximum rise 180°C. At an ambient temperature of 40°C, therefore, the maximum temperature of the winding is 220°C, which, according to the American standards, is the maximum permissible temperature for insulating material of class H. Comprehensive research has been devoted to the selection and testing of insulating materials suitable for these high temperatures. Silicon varnishes are the only type of impregnation used.

The transformers are designed to be safe against fire and explosion hazards even in the case of extreme overload and fault conditions. A full-scale test to destruction to demonstrate this property was carried out at the Asea High-power Laboratory at Ludvika on the 1st September, 1960, in the presence of representatives of the Swedish Board of Trade, the Government Electrical Inspection Authority and interested customers. One phase of a 500 kVA transformer for 3 kV ± 5 %/0.4 kV was selected as test object. The volume of the tank in relation to windings and core was the same as for an ordinary three-phase transformer, but its cooling capacity was relatively lower than that of a normal transformer.

NATURE OF THE TEST

For practical reasons the test was carried out with the low-voltage winding of the transformer short-circuited and with the power on the high-voltage side supplied from a generator with a short-circuit power of 20 MVA. After the temperature of the winding had been run up



- | | |
|---|--------------------------------------|
| 1 Temperature in the high-voltage winding | 4 Temperature in the upper gas layer |
| 2 Temperature in the high-voltage winding | 5 Gas pressure |
| 3 Input | 6 Cover temperature |

Fig. 1. Power supplied and temperature and pressure measured as a function of time in the course of the test to destruction on the dry-type transformer with insulation of class H. I_n represents the rated current of the transformer.

approximately 220°C , the transformer was loaded with 2, 2.5, 3 and 3.5 times the rated current for half an hour for each current value. The purpose of loading the transformer with increasing current for such short periods was to raise the temperature to extreme values in the course of a few hours. On the other hand, the test could obviously not provide any information about the durability of the insulation for any given time at a given temperature. To check the insulation of the windings, the test was interrupted every 15 minutes for a one-minute insulation test to earth at 120 % of the rated voltage with the transformer under no-load, the same generator being used. It was possible to change over from the load test to the voltage test in less than half a minute. At frequent intervals, too, sparks were generated in the gas enclosed in the tank with the aid of a built-in sparking plug to check that the gas formed at high temperatures could not be ignited.

In the course of the test, the following measurements were made:

- The gas pressure in the tank, which had been filled at the start of the test with nitrogen at atmospheric pressure
- The temperature of the tank cover
- The temperature of the gas in the top part of the tank
- The temperature in the hottest part of the high-voltage winding
- Input

The temperature was measured with a copper-constantan thermocouple. The gas pressure and the temperatures recorded, together with the power supplied during the test, appear in Fig. 1.

BREAKDOWN OF THE TRANSFORMER

During the voltage test, the transformer withstood the applied voltage after it had been on load for 15 minutes with 3.5 times the rated current. After another 15 minutes with the same current, the second voltage test showed that the no-load current had increased to 4–5 times its normal value, whereupon the test was stopped. Immediately afterwards, a leak developed in the gasket of the low-voltage bushing and gas began to escape. As is shown in Fig. 1, the temperature, before the test was interrupted, was approximately 700°C in the hottest part of the winding, and in the upper gas layer approximately 600°C . The pressure in the tank was approximately 3.5 atmospheres gauge. The temperatures recorded with the thermocouple, however, are undoubtedly too low. A copper-constantan element is not, at these high temperatures, particularly accurate. A calculation of the mean temperature of the windings based on the input at various current values gives a tempera-



Fig. 2. Detailed picture of the high-voltage winding after the test. (Z 11569)

ture of approximately 750°C at the time when the test was interrupted. It is certain, therefore, that the hottest part of the high-voltage winding had a temperature of about $1,000^{\circ}\text{C}$.

Since the gas temperature was above 600°C when the gas began to escape, it was within the range of possibility that the gas would ignite immediately and perhaps even explode. It was not possible to carry out any analysis of the gas, but since the gas formed mainly originated from the completely decomposed silicon varnish, a number of supplementary tests and calculations were carried out as follows. The quantity of hardened silicon varnish in this type of transformer usually amounts to approximately 3 g per litre of enclosed nitrogen. In a completely sealed metal vessel with a capacity of 1 litre, 3 g of hardened silicon varnish was introduced, and the vessel was then evacuated and filled with dry nitrogen up to atmospheric pressure. Upon heating in a muffle furnace up to 600°C , the pressure rose to 3.2 atmospheres gauge. After cooling the pressure dropped to 0.34 atmospheres gauge. The gas formed consisted mainly of hydrogen and hydrocarbons. When the gas, at a temperature of 600°C , was released from the vessel, it did not ignite spontaneously, but it was possible to kindle it, whereupon it burnt with a sooty flame. The temperature at which pure hydrogen will burn in air is

510°C. When the gas expands upon being released at a temperature of 600°C, the temperature undoubtedly drops far below its flash point. The test thus confirms that there is no risk that any leaking gas will ignite even if the temperature of the gas within the transformer has risen as high as to 600°C.

INSPECTION OF THE TRANSFORMER AFTER THE TEST

A relatively even layer of carbon dust, composed of the remains of the silicon varnish, had formed on the transformer tested. In certain areas, especially in the hottest parts of the high-voltage winding, the copper in the winding had melted and beads had formed (copper melts at 1,080°C).

The final voltage test clearly showed that minor internal short circuits had taken place, since a number of burnt-out turns of the winding could also be observed. A close-up view of the high-voltage winding after the test is shown in Fig. 2.

After the test a 50 c/s voltage test was carried out on the insulation to earth of the high-voltage winding at the lower yoke. The dielectric strength had dropped to approximately 50 % of the guaranteed value for a new transformer.

CONCLUSIONS AND SUMMARY

The maltreatment given to the transformer in the test to destruction would hardly have any parallel in reality. Even extreme overloads could not lead to temperatures of the order of those reached in the test. In exceptional fault conditions, however, provided that the normal protective arrangements failed completely, abnormally high temperatures might be reached, although it would be extremely unlikely that the final temperatures recorded in this test would occur.

This test has proved convincingly that the tested transformer type will withstand, for a short period, a temperature which approaches the melting point of the copper in the winding without there being any failure of the insulation. The maximum temperature of the enclosed gas would then be more than 600°C and the pressure approximately 3.5 atmospheres gauge, provided that no leak had occurred. Tanks of conventional design would never withstand such a high pressure without leaking. Leaking gas, even at such a high temperature as 600°C, would not ignite. The conclusion is therefore that *the Asea dry-type, hermetically sealed transformer can be considered as safe against fire and explosion hazards* even under the most extreme fault conditions. This was also the opinion of the experts present.

NEW HIGH-SPEED D.C. CIRCUIT-BREAKER FOR 3,000 V

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Asea Reg. 5345

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In large converter substations for traction systems there is a need for high-speed circuit-breakers having a very high breaking capacity. Asea have therefore developed a new type of high-speed circuit-breaker for 3,000 V, 1,600 A, which satisfies the most stringent requirements as to good breaking capacity and which, furthermore, is of compact design.

High-speed circuit-breakers are employed as short-circuit protection in high-power d.c. circuits for voltages up to about 4,000 V. The purpose of the circuit-breaker is, in the event of a short circuit, to limit as

quickly as possible the current, which otherwise might attain a dangerously high value for the installation. Once the current has been limited, the interruption should be completed rapidly. The arc voltage must be maintained at a reasonable level, usually not more than twice the service voltage of the installation.

In addition to acting as short-circuit protection, the circuit-breaker must also be capable of coping with all the different types of interruption that may occur in an installation, including also the interruption of currents amounting to a few amperes.

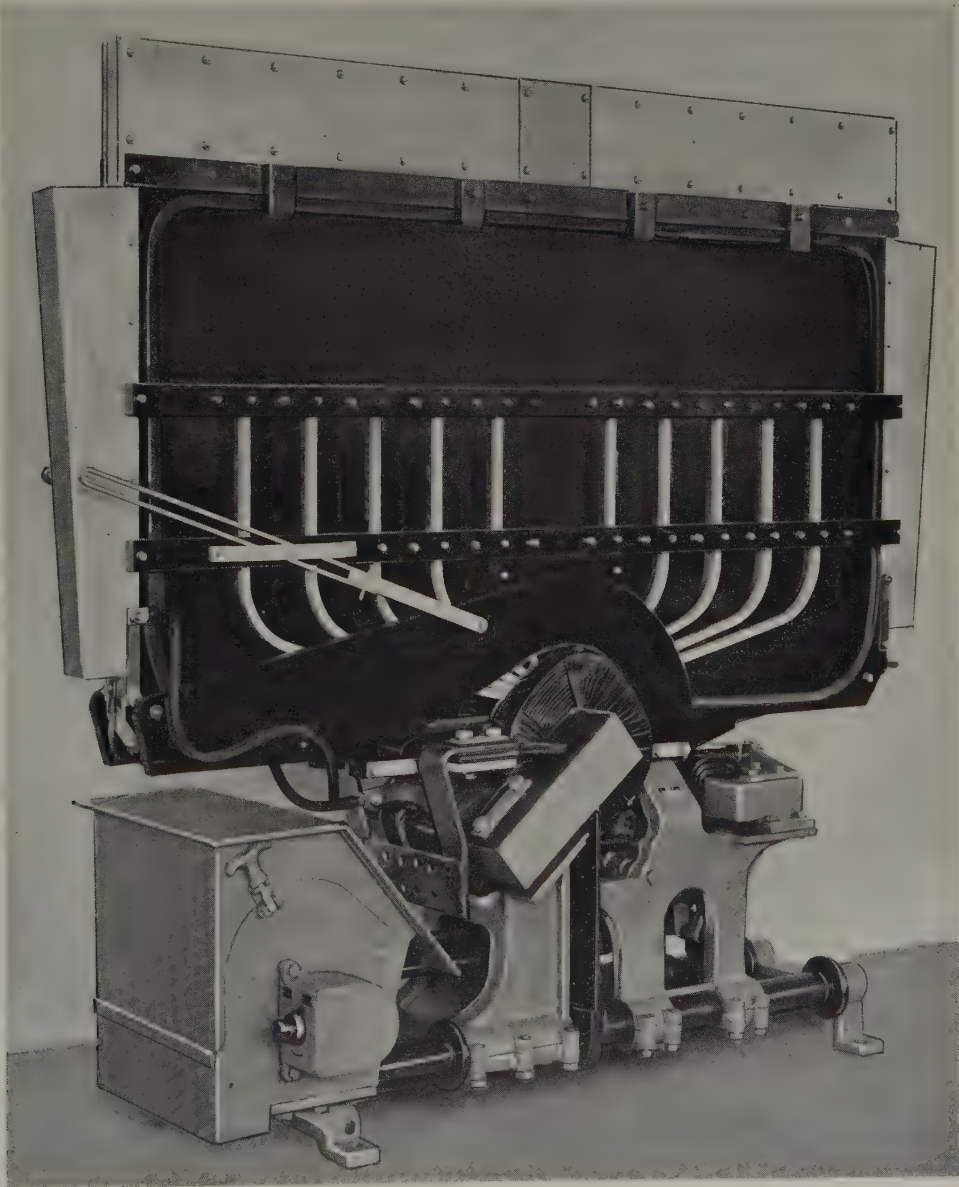


Fig. 1. High-speed d.c. circuit-breaker rated at 3,000 V, 1,600 A. (53140)

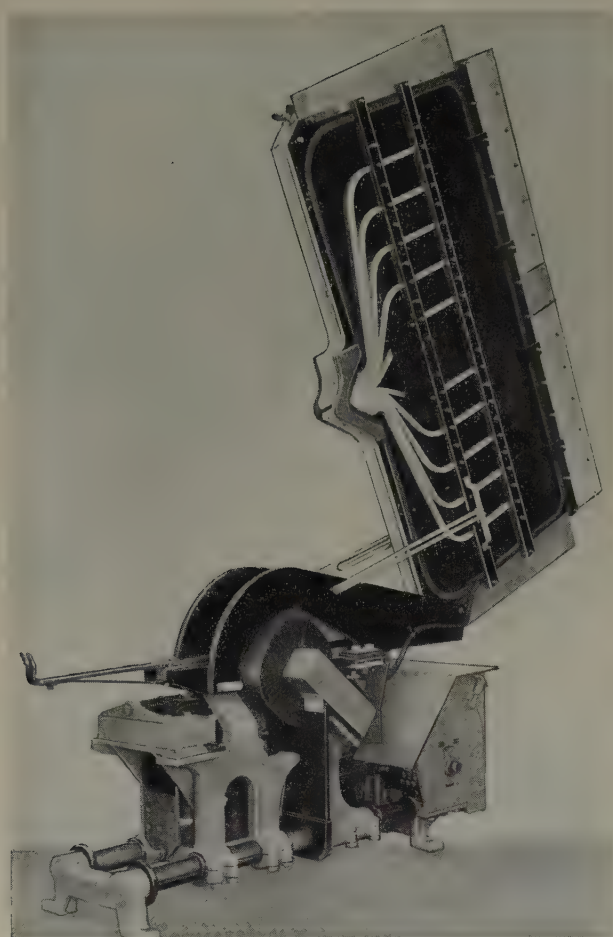


Fig. 2. The arc chute raised for inspection. (53141)

NEW DESIGN OF HIGH-SPEED CIRCUIT-BREAKER

Asea have manufactured and supplied a large number of high-speed circuit-breakers since the beginning of the 1930's to converter substations for traction systems. The continued expansion of railway networks as well as the linking together of converter substations have been accompanied by ever growing short-circuit powers. This factor has naturally placed even greater demands on the high-speed circuit-breakers forming part of the protection in these substations. The modifications which have been introduced on earlier designs of the circuit-breaker have satisfied to a large extent these requirements, but at the same time resulted in the circuit-breakers becoming very bulky, due above all to the size of the arc chute. A new type of high-speed circuit-breaker has therefore been developed in order to meet the latest requirements as to a high breaking capacity, while at the same time keeping the breaker as compact as possible.

The new circuit-breaker, which is illustrated in Figs. 1-3, rated at 3,000 V, 1,600 A, is based from the mechanical point of view on an earlier design, which has been in practical use over a long period and proved to be very

reliable. The arc-extinction device, however, is of completely new design. Apart from requiring considerably less space than earlier designs, it exerts a better control over the arc and consequently also over the highest voltages occurring.

Tripping arrangement

The circuit-breaker is available with the following three types of tripping arrangement:

Reverse-current tripping

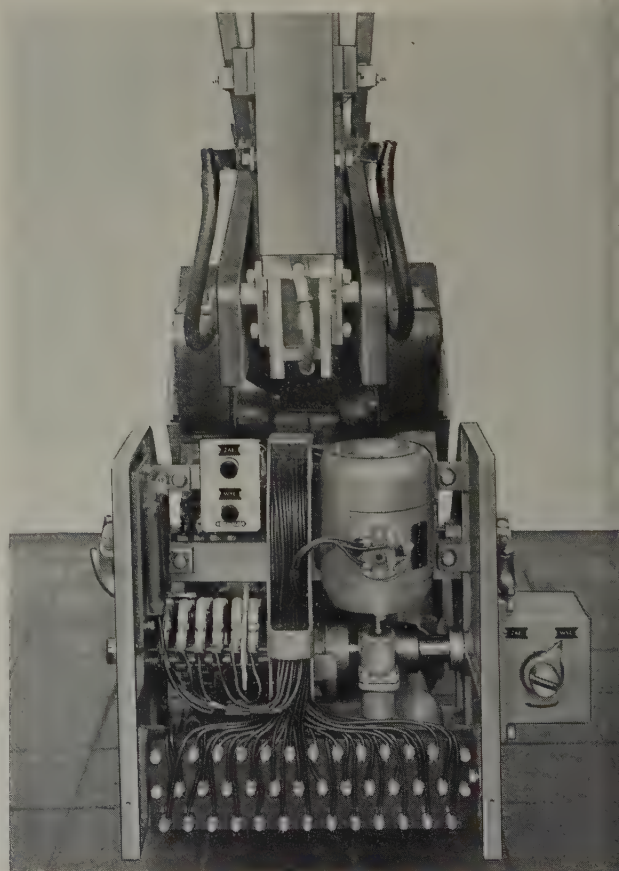
This type of tripping is used mainly when the circuit-breaker is employed as a cathode switch for mercury arc rectifiers. In the case of a 1,600 A circuit-breaker tripping takes place for a reverse current of approximately 150 A.

Polarised over-current tripping

This implies that the circuit-breaker trips for an over-current in only one direction of the current.

This form of tripping is used in substations for traction systems. In these stations two or more lines are connected together. When one of the lines is subjected to a high load, it will be supplied from the other ones. In the case of a short circuit on one of the lines, this is tripped.

Fig. 3. The cover over the operating gear removed. (56041)



its high-speed circuit-breaker. The high-speed circuit-breakers of the other lines are not affected, since the direction of the current for these is opposite to the tripping direction.

Non-polarised over-current tripping

The circuit-breaker trips for an over-current irrespective of the direction of the current. A circuit-breaker designed for this form of tripping is held closed by means of a patented mechanical latch. No hold-on voltage is consequently needed, and this tripping arrangement is therefore preferable when polarised tripping is not required.

The circuit-breaker mechanism for a non-polarised circuit-breaker is illustrated in Figs. 4 a-c. When the current attains the tripping value, the armature 8 is attracted by the magnet 7, which causes the rod 6 and link 4 to be actuated. The latter then first turns towards the stop in the contact arm 10, thus releasing the latch. After this, the force exerted by the armature is transmitted to the contact arm, which is rapidly pulled out. This movement is assisted also by the spring 9, which prior to the tripping held the contact closed with sufficient force. In the circuit-breakers designed for reverse-current tripping and polarised tripping the mechanical latch is replaced by a hold-on magnet, and the tripping force is imparted by a powerful spring.

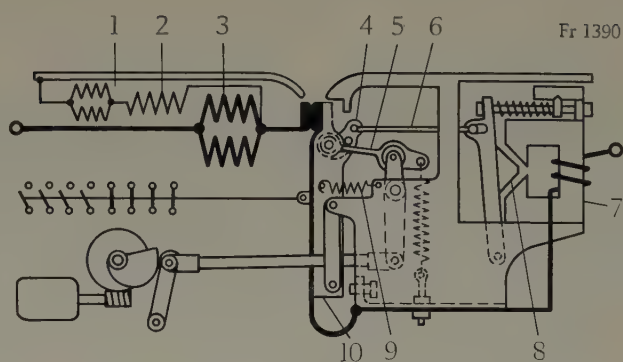
The arc-extinction device

The arc-extinction device, which has been patented, is shown schematically in Fig. 5. If the short-circuit current is to be limited rapidly, it is not merely sufficient for the circuit-breaker contacts to open rapidly, but the arc must be drawn out with the greatest possible speed to such a length that the arc resistance limits the current.

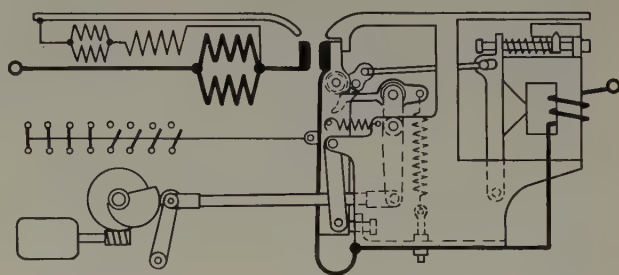
For this reason, the arc-extinction device has two permanently energised blow-out coils 3, which generate a strong magnetic blow-out field in the interruption gap between the contacts. When the contacts open, the arc is drawn rapidly up on to the arcing horns, and at the same time the extra blow-out coils 1 and 2 are connected up. One of these blow-out coils (2), which is mounted on the same blow-out core as the permanently energised blow-out coils, is intended to assist in the interruption of very low currents.

The other two extra blow-out coils (1), connected in parallel, are mounted, one on each outer side of the arc chute. These blow-out coils generate a magnetic field that strives to draw the arc outwards and upwards within the loop they surround.

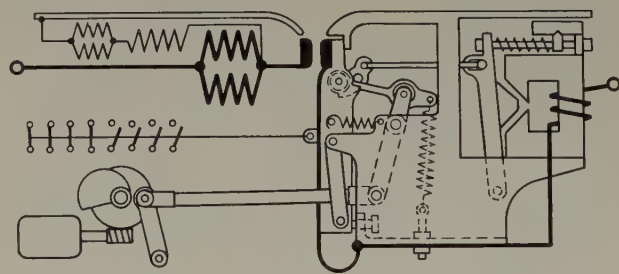
An arc which is to yield an arc voltage drop of about 1000 V requires a considerable length. A long arc will,



a) The circuit-breaker in the closed position



b) The instant after an over-current release



c) The circuit-breaker in the open position

1	Blow-out coils	5	Latch	8	Armature
2	Blow-out coil	6	Rod	9	Spring
3	Blow-out coils	7	Magnet	10	Contact arm
4	Link				

Fig. 4. Schematic diagram of the circuit-breaker mechanism for a non-polarised circuit-breaker.

however, be unstable and very difficult to manage, and thus a total or partial short circuit of the arc can easily occur. This leads to a temporary increase in the short-circuit current, a prolongation of the breaking time and excessive wear on the contacts and arc chute. There is even a possibility that the circuit-breaker will not be capable of completing the interruption. In order to provide a better control over the arc, the arc chute has been divided into a number of compartments with partitions between the compartments clad with resistor strips 11 of a highly resistant alloy steel possessing an elevated melting point. When the arc is drawn up into

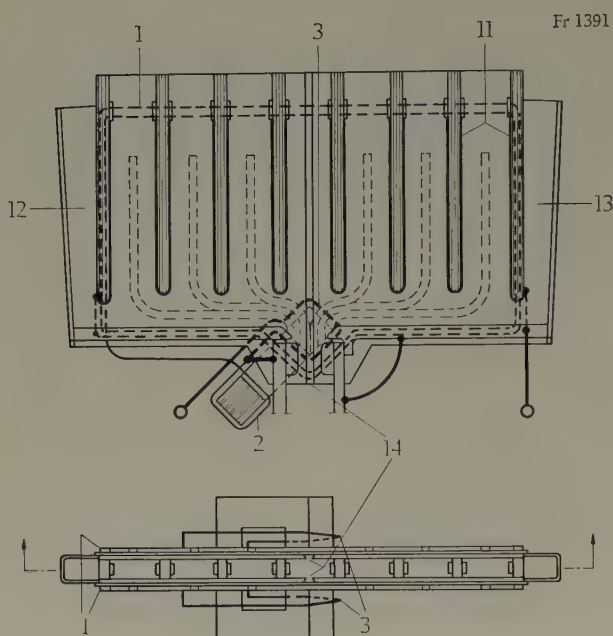


Fig. 5. The arc-extinction device for high-speed circuit-breakers.

the chute, these resistor strips are connected in at the same time as the arc is split up into a number of smaller arcs connected in series via the resistor strips. The short arcs are then drawn upwards with great rapidity, and thus no damage due to burning will arise on the resistor strips. The total voltage across the break will be very stable and it rises very uniformly and rapidly.

The strongly ionised gas formed during the interruption passes not only upwards from the lower part of the arc chute but also out through the ducts 12 and 13. This lessens the risk of ionised gas being forced against the contacts and causing restriking.

The arc chute within which the arc is controlled is made of a material possessing a very high resistance to arcs. The asbestos material chosen is, however, hygroscopic and thus its insulation properties are not so satisfactory. In order to achieve the necessary insulation between the contact poles when the contacts are open, the sides of the chute were impregnated in earlier designs. This impregnation, however, had an unfavourable effect on the arc extinction, and eventually was burnt away. The new arc chute has therefore been provided with insulating slots 14, between the contact poles, thus ensuring a very satisfactory insulation.

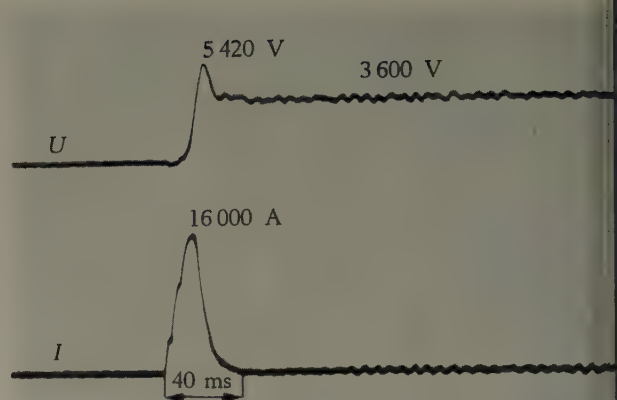


Fig. 6. Oscillogram from a breaking test in a converter station for a traction system. The prospective current was 42,000 A. (Z 11190)

The operating gear

In many cases a small storage battery is used to supply the necessary operating power for the high-speed circuit-breaker. For this reason it is essential that the circuit-breaker should require as little operating power as possible. The new circuit-breaker has therefore been fitted with motor-operating gear where the motor requires only 100 W. The operating gear is shown schematically in Figs. 4 a-c.

Performance

The contact opening time of the circuit-breaker, that is to say, the time taken from the instant when the current reaches the set tripping value until the contacts are open, depends on the rate-of-rise of the current, but lies within the range of 2 to 4 ms. These values apply to all three types of circuit-breaker.

The breaking time is naturally largely dependent on the inductance of the circuit as well as on the short-circuit power of the installation. A few examples of the breaking times from laboratory tests performed at 3,600 V may be mentioned:

With a resistive circuit having only the inductance of the installation, namely 0.7 mH, and a prospective current of 22,000 A, the breaking time is 16 ms. With a circuit having an inductance of 5 mH and a prospective current of 13,200 A, the breaking time is 35 ms.

An oscillogram recorded from an exacting breaking test is reproduced in Fig. 6.

NEWS IN BRIEF

VISIT BY NEW YORK SECURITY ANALYSTS

On 11th and 12th April, a group of thirty-five New York Security Analysts with wives visited Sweden, as part of a ten-day European trip.

The group paid visits to a few large industrial companies and met Swedish bankers.

During the morning of April 12th, the group visited Asea, Västerås. The Security Analysts made a short trip through some of the works, and had talks with the Asea management. The visit ended with lunch in the town.

The American guests expressed their sincere interest in Swedish and other European stock. They were, however, surprised by the fact that significant investments in Swedish industry were made impossible by a multiplicity of official regulations.

Asea Reg. 9794



(Z 12366)

ELECTRICAL ENGINEERS EXHIBITION

The Asea representatives in Britain, Fuller Electric Ltd., took part in the Electrical Engineers Exhibition held at Earls Court, London, from 21st to 25th March, 1961. The photograph shows the presentation made of the part being played by Asea and Fuller Electric Ltd. in the Cross-Channel D.C. Power Link. The schematic indication of the flow of current on the map was controlled by the public from the desk below. When current was shown to flow from England to France, a description of the entire scheme in the English language was illuminated on the desk. When the flow of current was from France to England, the same description in the French language was illuminated. Considerable interest in the exhibit was shown by the visiting public. A 1:10 scale model of one of the two rectifier transformers being built by Fuller's for the Lydd Terminal Station of the Cross-Channel Scheme was also exhibited.

Asea Reg. 9547



(Z 12605)

SWITCHING STARTERS WITH CONTACTORS OF TYPE EF

The new contactors of type EF and the thermal relays of type RVO, RVL and RVM require little space and can readily

be combined and adopted to make, for example, star-delta starters, direct-on-line reversing starters and direct-on-line

pole-changing starters. A series of closed casings [design form S 32 in accordance with the Swedish Standard S 21 21, IP 43 in accordance with IEC-dr 17 B(CO) 12] has been developed for this purpose (Fig. 1). The casings have pushbuttons and signal lamps or, in case of the 10 A size, a mechanical indicator which shows the position of the contactor.

Both star-delta starters and direct-on-line pole-changing starters for reversing are available, and Fig. 2 shows a direct-on-line pole-changing starter of this kind of type KLEF 612 with contactors rated currents of 60 and 40 A, thermal relays of type RVM and fuses for the control-current circuit. Since the contactors are accessible from the front for maintenance and inspection, it has been possible to achieve a compact design. This is particularly suitable where only a limited number of contactors are switched on simultaneously, since in these cases the size of the casing is not determined by the heat losses.

The switching starters are also available in a non-enclosed design for mounting in, for example, contactor-type switchgear. Fig. 3 shows a direct-on-line pole-changing starter of type KZEXF 012 for a two-speed motor with a reconnectable winding. The pole-changing starters are always provided with thermal relays for each speed, thus ensuring correct overload protection.

Asea Reg.

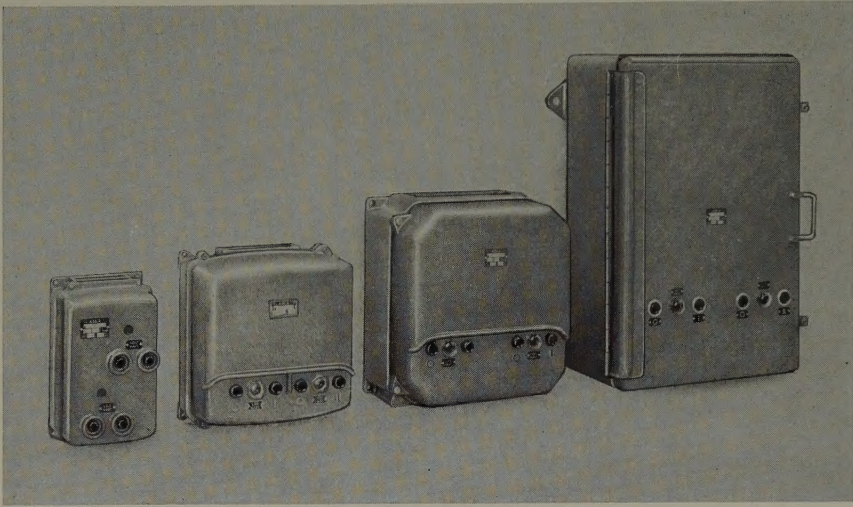


Fig. 1. Enclosed direct-on-line pole-changing starters of type KZEF 122, 222, 422 and 1012. (55800)

Fig. 2. Direct-on-line pole-changing starter for reversing of type KLEF 612 with contactors for rated currents of 60 and 40 A, thermal relays of type RVM and fuses for the control-current circuit. (54932)

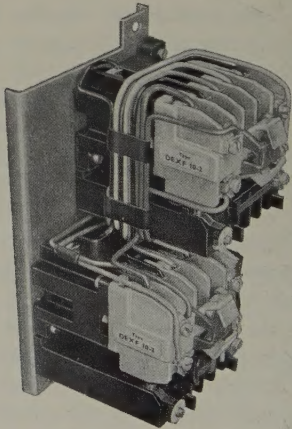
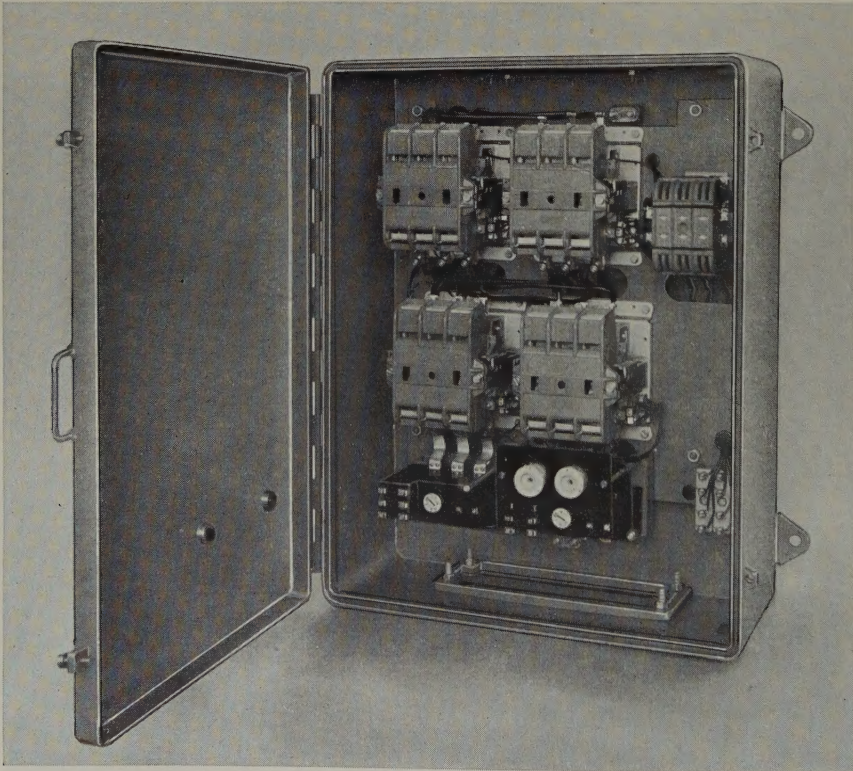


Fig. 3. Direct-on-line pole-changing starter of type KZEXF 012 for a two-speed motor with reconnectable winding. (54649)

THREE-PHASE UNDER-VOLTAGE RELAY TYPE ROTA

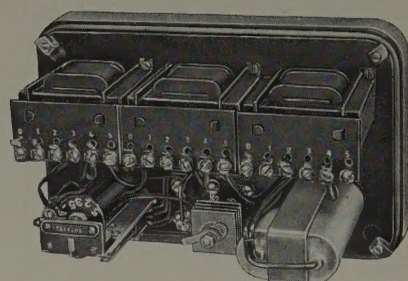
The Asea under-voltage relay type ROTA indicates voltage drops, both symmetrical and unbalanced, in three-phase systems. In addition, it detects phase interruptions, provided that the load does not maintain the voltage over the interrupt-phase, that is to say, the load should consist, in the main, of synchronous induction machines which continue to operate when supplied by two phases only.

The relay has recently been redesigned, and, in conjunction with this, it has been provided with a new case (size H8). The new design has the following data:

Connectable rated voltage: 110, 190, 230 and 380 V
Standard rated frequency: 50 or 60 c/s



(49628)



(52464)

In the standard design, the relay operates when *one* of the line voltages falls to 60 %, or when two or all three simultaneously fall to 75 %, of the rated voltage. In the case of an unbalanced voltage drop it is assumed that the other line voltages are maintained at the rated value.

In the case of a phase interruption, the relay operates even though the remaining line voltages simultaneously rise by 10 %.

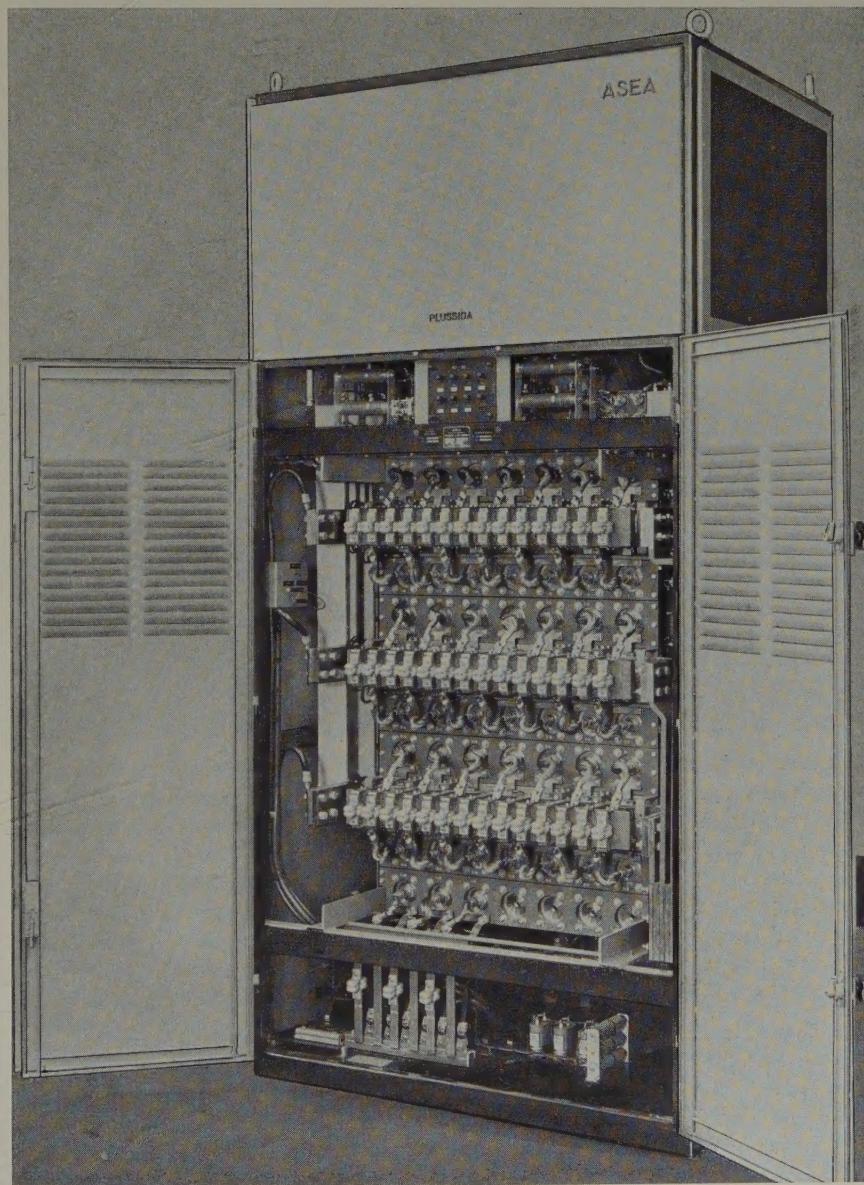
The relay has two two-way contacts. A complete description is given in Asea Brochure No. 7671 E. Asea Reg. 5623

40 kW GERMANIUM RECTIFIER FOR A VACUUM ARC FURNACE

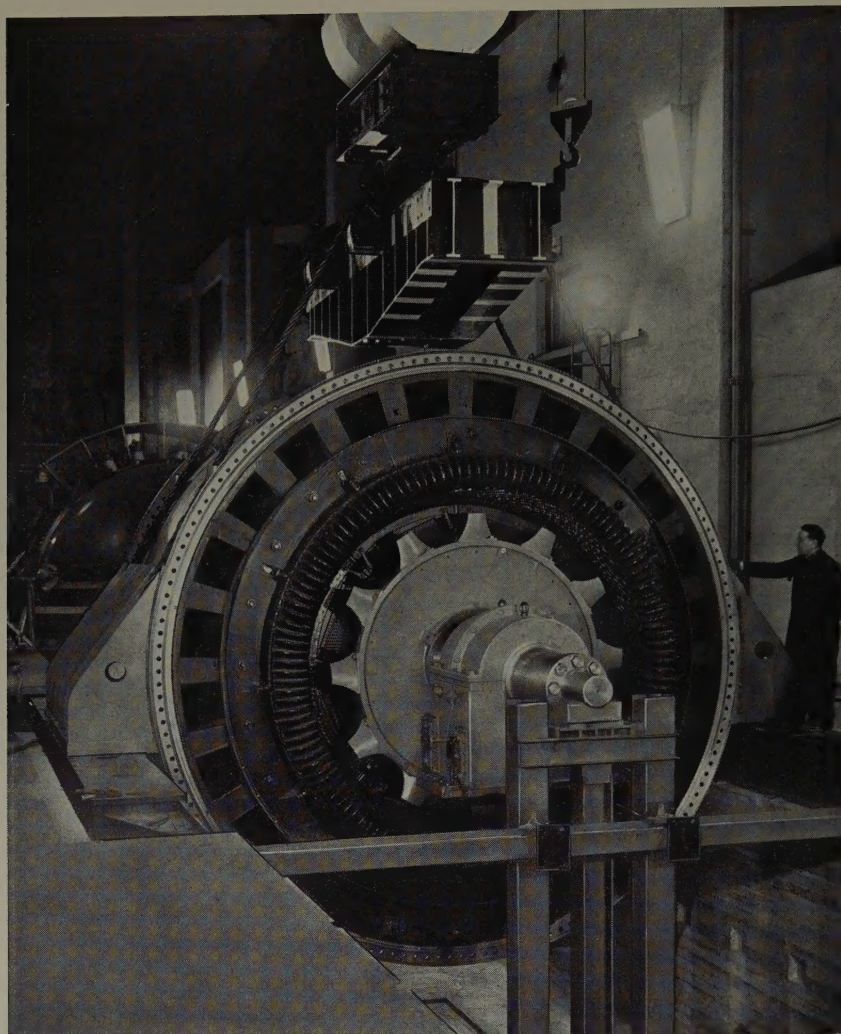
In August 1960, a rectifier installation with a rating of 40 V, 7,500 A, d.c., for driving a vacuum arc furnace was supplied to Sandvikens Jernverks AB, Sandviken, Sweden. Furnaces of this kind are used to remelt ingots at a high temperature and under low pressure, the ingot acting as an electrode. In this way, gas divisions in the electrode are released, thus providing a high-grade gas-free ingot. The high temperature is achieved by moving the electrode to melt in an atmosphere fed by direct current.

The rectifier installation is built in accordance with the most modern principles relating to semi-conductor installations at high current. It is fed from a 3 kV supply network and consists, in the main, of three units: an oil-insulated transformer and transducer unit, an excitation transformer for exciting the transducers which are built into the transformer tank, and a fan-cooled rectifier cubicle as shown in the illustration. The cubicle contains germanium diodes of Asea manufacture. These provide high efficiency at the stage in question. The diodes are protected by special fuses which can be seen in the photograph.

It is required of the rectifier that it should have a no-load voltage of 70 V and should provide an arc current which can be continuously regulated between 0 and 7,500 A and is kept constant at a set value at voltages between 15 and 70 V. The voltage is determined by the position of the electrode. The voltage is set and the rectifier is supervised from a control desk which is common to the vacuum furnace installation. Asea Reg. 490



(55419)



(56281)

SYNCHRONOUS CONDENSER OF RECORD SIZE SUPPLIED TO THE SWEDISH STATE POWER BOARD

A 100 MVA, 750 r/m, 21.5 kV synchronous condenser for the Swedish State Power Board was taken into service on 8th February, 1961. The machine is the fourth large, hydrogen-cooled, synchronous condenser which Asea have supplied to the State Power Board. The three machines supplied previously each have a rating of 75 MVA, the hydrogen coolant being kept slightly above atmospheric pressure, while the 100 MVA rating of the new machine is at a hydrogen pressure of 1 atmosphere gauge. The improved cooling conditions made possible by a higher gas pressure were studied by means of tests on the machines supplied previously. The new machine was designed on the basis of the temperature rise, rather than on the reactance requirements.

Heat runs at the full load of 100 MVA, 23 kV and with a hydrogen pressure of 1 atmosphere gauge were performed in June of this year. The temperature rise of the stator winding above the cooling water – not the hydrogen coolant – was found to be about 50°C. The guaranteed temperature rise was 55°C. The temperature rise of the rotor winding at full load and 23 kV was found to be about 65°C, the guaranteed value in this case being 80°C. The values for the temperature rises were guaranteed to apply over a voltage range of ± 7 per cent. The measured values lie in fact very close to those stipulated in ASA C 50.1-1955 and are considerably lower than those specified in B.S.S. 2730:1956 for hydrogen-cooled turbogenerators.

The illustration shows one of the assembly operations during which the rotor is supported at the shaft ends while the stator is slid over it. The large end-bells which contain the coolers for the hydrogen were then fitted. The bearings, which were suspended from the shaft while the rotor and stator were being assembled, rest on brackets in the end-bells, which, in their turn, stand on the machine foundation.

Asea Reg. 4423

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